

Shambhala Research Project

Artificial Intelligence to
accurately and instantly
determine spot rate of carbon
absorption in a defined forest



Joint research initiative with PanIT Institute, USA Chapter and H8Alumni group in response to the United States–India Science and Technology partnership on core climate change technologies

The project uses
Quantum Technologies & Artificial Intelligence
for Transforming Forests & Lives

INDIAN PARTNERS



US PARTNERS

Institute

The PanIIT Institute is the global applied research arm of the IIT Alumni Council.

The Institute has operations around the world and sponsors research centres in South Asia, North America, Japan, Asean and Western Europe.

IIT alumni who have a doctoral degree are eligible to be Distinguished Fellows, Charter Members and Life Members.

The gold standard among the IIT alumni are the Distinguished Fellows who are rated as the best in their awarded field among all the 50,000+ alumni registered with the IIT Alumni Council. The Charter Members are the eminent alumni in each domain.



. an IIT Alumni Council initiative .

A RESEARCH PLATFORM
TO IDENTIFY, DEVELOP &
DEPLOY APPROPRIATE
TECHNOLOGIES



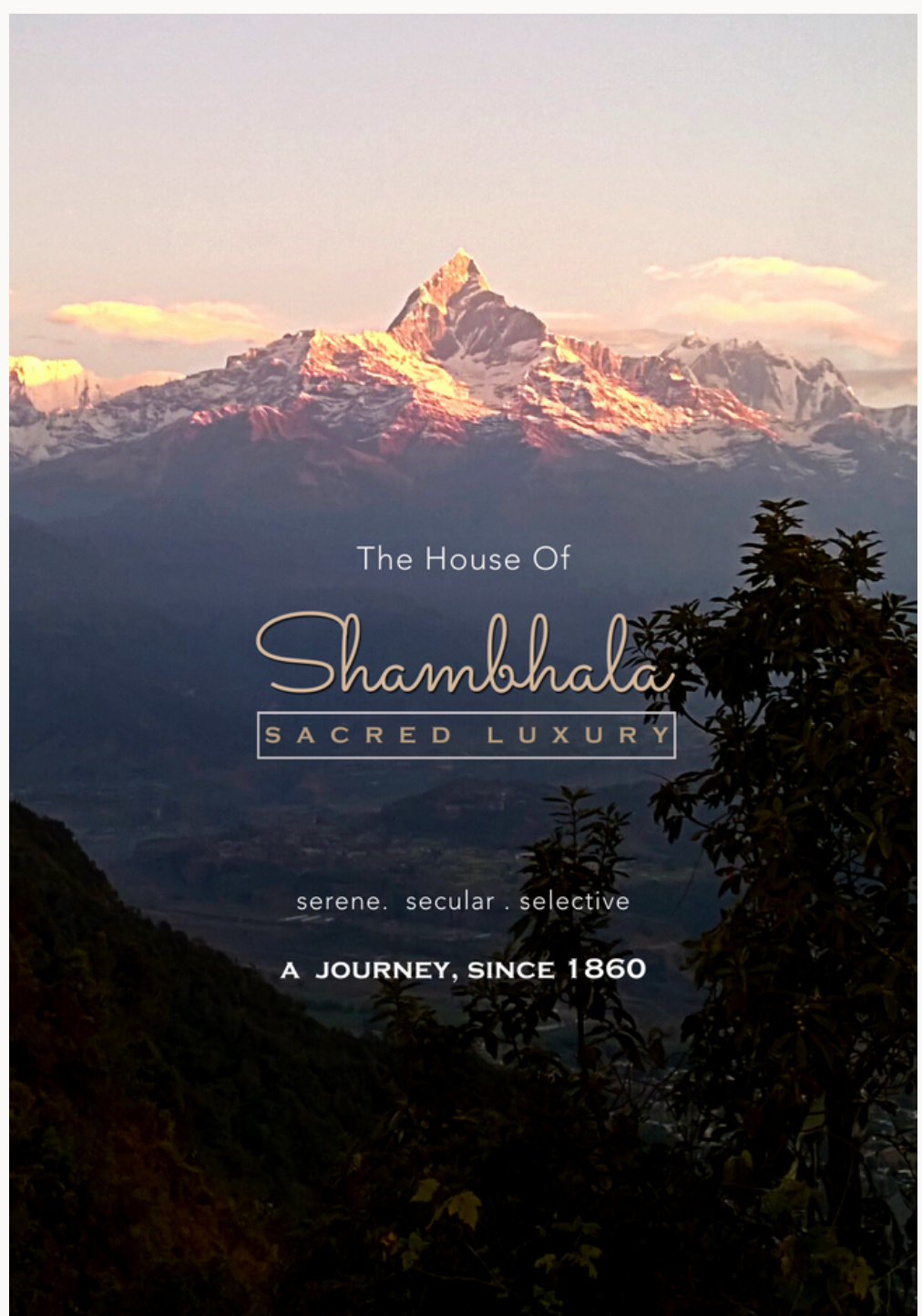
Shambhala

Founded in 2013, the House of Shambhala has a rich history that dates back to 1860 in the unspoiled upper Himalayas of Himachal Pradesh, India, with a legacy of Sustainability and environmental Consciousness.

Shambhala journeys are curated to counter environmental degradation, pollution & negative effects of a disrupted food chain; to revitalise forests, mitigate and reverse the adverse impacts of climate change; and empower local communities and their livelihoods.

Shambhala was declared the winner of the first cohort of the MegaLab initiative in 2020. Institutional Investors include the IIT Alumni MegaFund and the US based Ashmolean Fund.

Shambhala is committed to revitalising 100,000 sqkm of forests in the four target zones of upper himalayas, north east, central India and the western ghats. Shambhala works with local communities.



Satish Mehta

A certified investment banker and professional cinematographer, Satish serves as Head of Compliance & Regulatory on investment committees/ boards of several private equity funds. He played a key role in creating the startup regulatory framework. Satish holds a BTech Chem Eng from IIT Bombay & and an MMS in Operations Research from JBIMS, Mumbai University. He is an authority and visiting faculty in photogrammetry & cinematography.

He received the Acharya PC Ray award from the President of India in 1987 and the Technology Day Award of DST in 2008.

Satish was instrumental in creating the IIT Alumni movement in the late nineties. He has been an active volunteer in its initiatives including IIT Alumni Council & the MegaFund. . He was part of the Covid Task Force and serves on several working committees. He was instrumental in creating several institutions of national importance including TRAI, SEBI, SIDBI, BSNL and IIT Alumni Council.



Srinivas Rachakonda

A seasoned corporate leader from the oil and gas industry. Senior Advisor McKinsey & Co, former President Essar Oil and founding team member that built the Jamnagar oil refinery. A Chemical Engineer from IIT Bombay, Srinivas left his global corporate career & an eight-digit salary to move to a remote village in the Bandhavgarh Tiger Reserve's buffer zone in Madhya Pradesh. India.

He was awarded the Change Maker of the Year 2023 and is rated amongst the leading thought leaders globally in the area of elimination of invasive species.

He now runs the Prakriti Prerna Foundation, addressing the challenges of mass dense afforestation in the area. Srinivas believes his work will create a new industry worth billions of dollars in climate change related revenues while also undoing some of the harm caused by the chemical plants he helped build.



Neelkant Shukla

An accomplished senior leader in strategy, engineering, and technology, Dr Shukla has close to thirty years work experience as a Chemical engineer and corporate leader in green chemistry, sustainability and in building net-zero industries.

Dr Shukla was awarded the Distinguished Fellow by the Institute as the most eminent IIT Alumni Council member in the world in the area of Carbon sequestration.

Neelkant holds a B Tech from IIT Bombay, an MS & PhD from the University of Louisville, all in Chemical Engineering. He is an adjunct faculty of Rowan University in New Jersey. He stands tall as a corporate leader with close to 30 years experience in the sustainability and net zero carbon space. He speaks his mind and is routinely invited to chair alumni events in his domain.

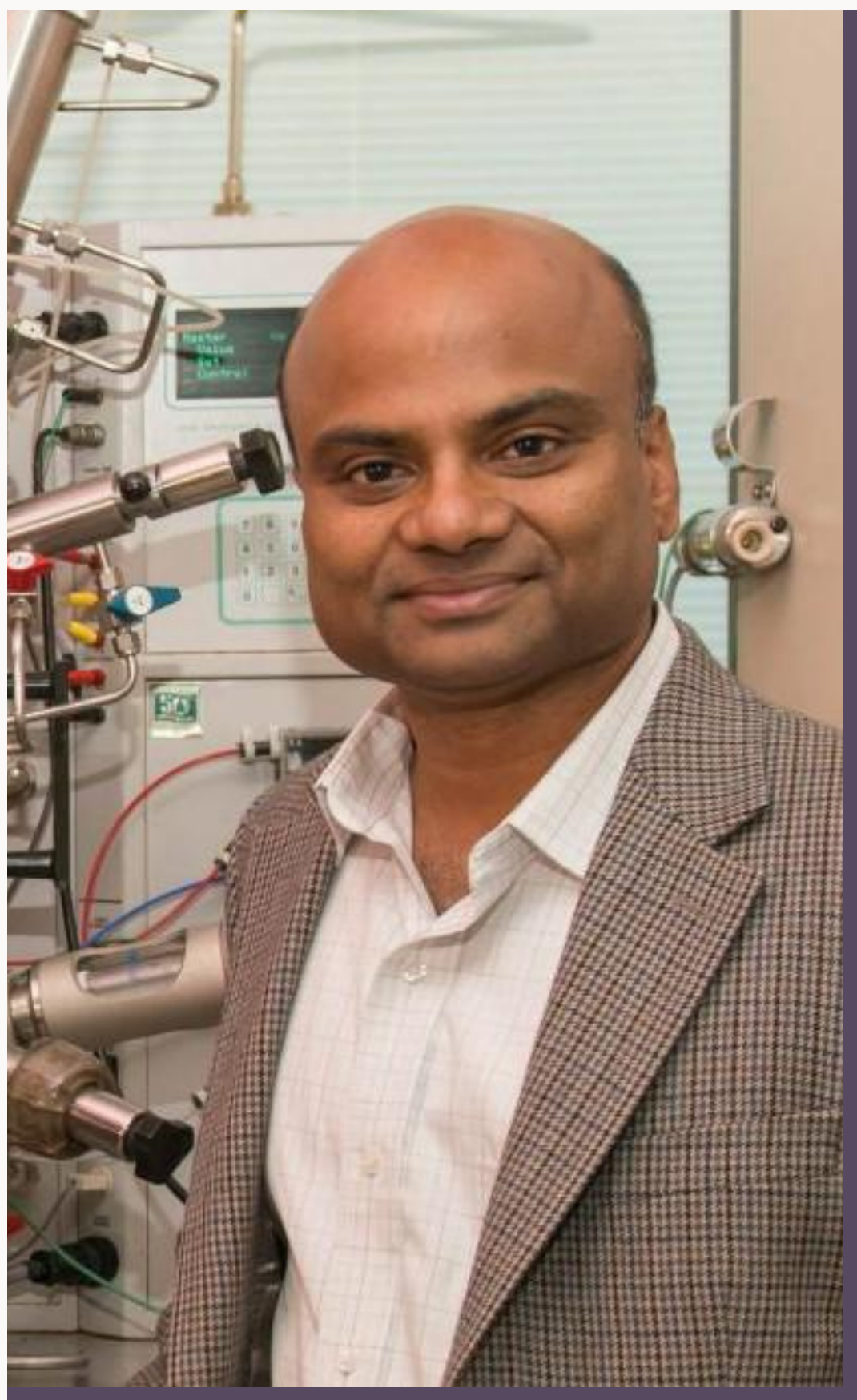


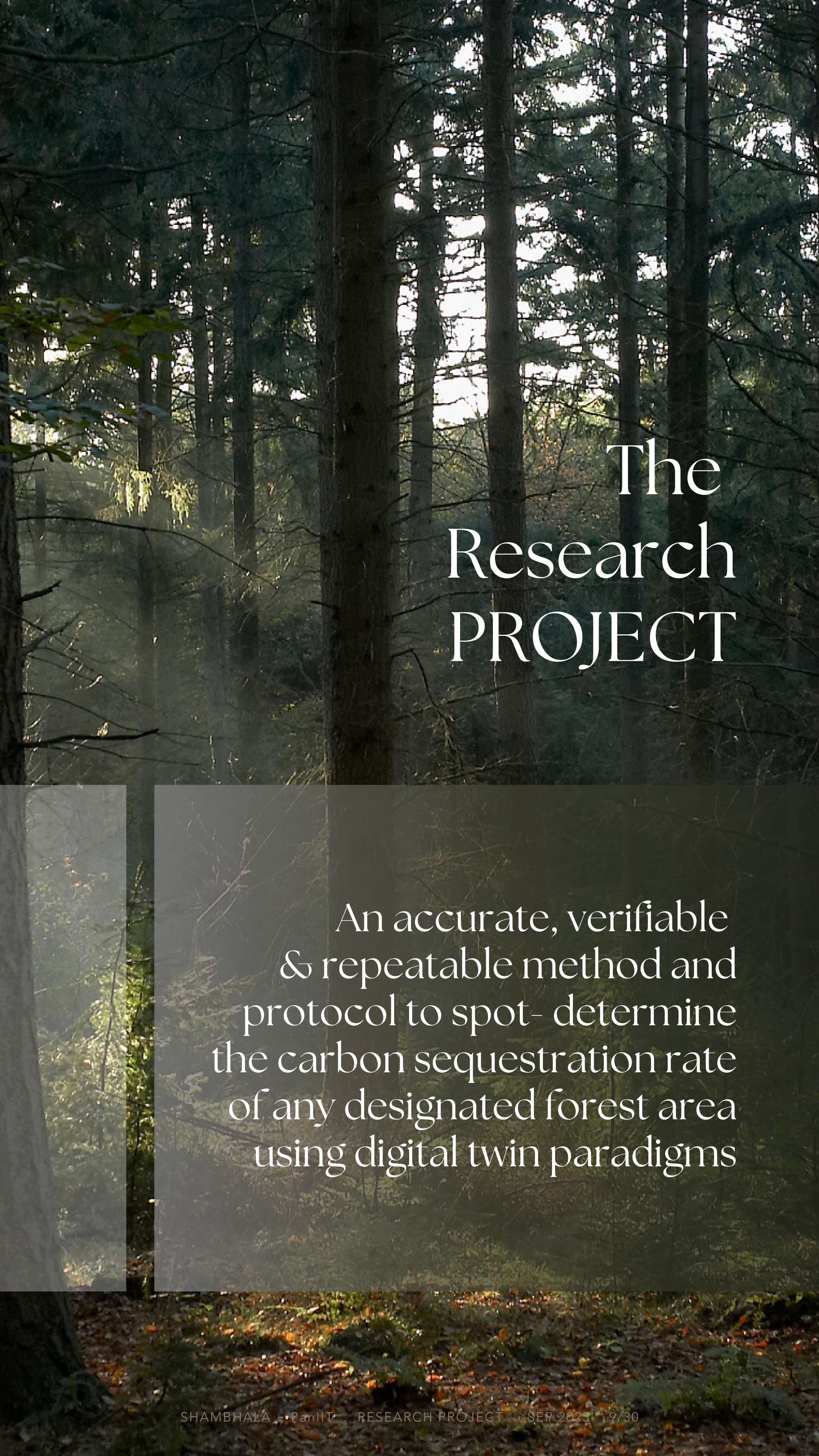
Upal Ghosh

An eminent professor in environmental science & engineering at the University of Maryland. He is a B Tech Chem Eng. from IIT Bombay, an MS & PhD from State University of NY in Civil & Environmental Eng. His research groups have won recognition for their findings and applications, and acquired patents, etc., in the areas of toxic pollutants, climate change remediation and restoration, sequestering carbon, etc.

Prof Ghosh was awarded the Distinguished Fellow by the Institute as the most eminent IIT Alumni Council member in the world in the area of detoxification based on microbial conversion.

Prof Ghos has been a PI or Co-PI on more than 50 research projects & has authored more than 80 publications in peer-reviewed journals. He is an Associate Editor of Environmental Toxicology & Chemistry journal. He co-founded two companies Sediment Solutions & RemBac Environmental, that are transitioning sediment remediation technologies.





The Research PROJECT

An accurate, verifiable
& repeatable method and
protocol to spot- determine
the carbon sequestration rate
of any designated forest area
using digital twin paradigms



The specific problem being addressed...

Forests are in dire straits because of tree felling, dominance of invasive species, falling water table, declining rainfall, rising temperatures, dwindling biodiversity affecting the circular economy, etc.

As a result they are in need of interventions to revitalise them. It is believed that these interventions - which may range from planting new trees to removing invasive species - could help increase the rate of carbon sequestration.

The reward mechanism for such interventions is the issuance of carbon credits. These carbon credits are purchased - either on the voluntary market or the regulated markets by polluting organisations to neutralise the pollution attributable to them.

However the challenge lies is in measuring the carbon credits. How does one measure, now much additional carbon is being absorbed because of these interventions. There is no known method or protocol to accurately, cost effectively and quickly measure this quantum

Proposed Solution

and the underlying S&T
novelty/innovation driving the solution



digital twin technologies

The proposed project involves using Computervision to accurately estimate the carbon sequestration ability of the defined forest area on a spot basis. The protocol can be repeated at regular intervals to measure the improvement or reduction in carbon sequestration ability.



The proposed project involves three steps



preparatory phase
Identification of species



mapping
& multispectral imaging



correlating data
to images

1st phase

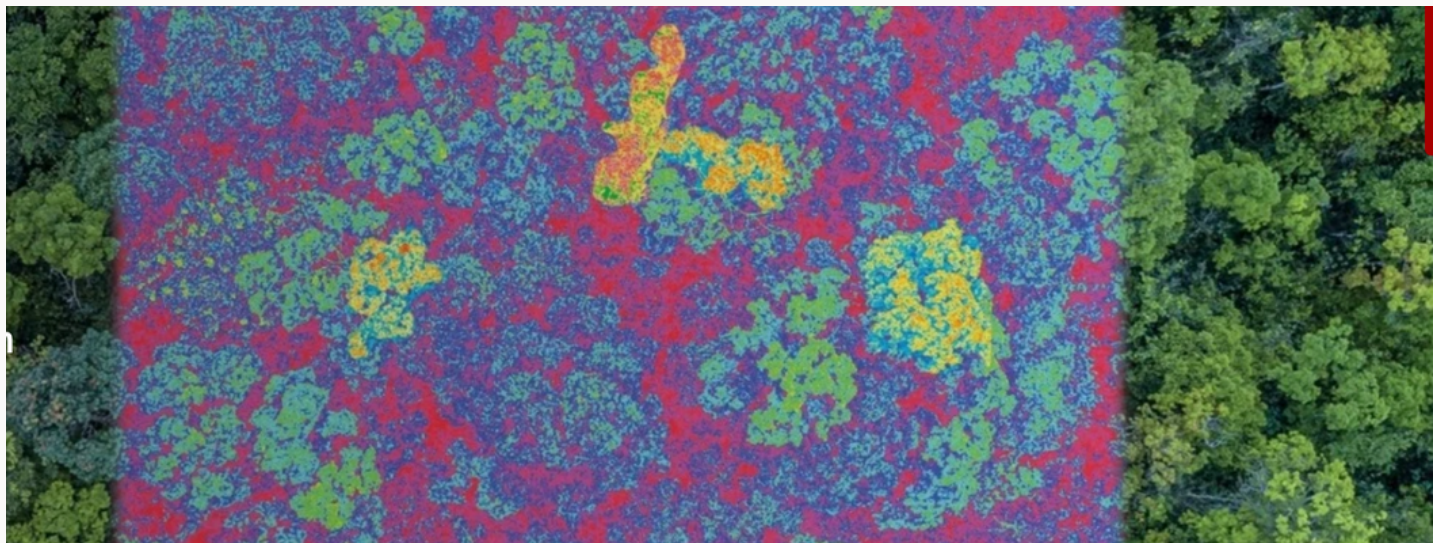


PREPARATORY PHASE IDENTIFICATION OF PLANTS

The preparatory phase involves identifying the key plants and species in the designated forest area which collectively account for at least 80% of the total green vegetation in the designated area. Thereafter these individual plant are studied to characterise their genetics, epigenetic and physical structure.

The same is then correlated to hyperspectral images taken of these plants for near use hyperspectral cameras and stimulated Raman spectroscopy equipment to understand the buildup of these plants at close to cellular and molecular level. For lack of a better word, we can call these digital twins of the real individual plant. For the identified area of the pilot, this area has around 20 species of vegetation which collectively account for over 80% of the vegetation

2nd phase



MAPPING & MULTISPECTRAL IMAGING

The second phase involves mapping the entire forest area using thousands of optical and multispectral images taken from road level, drones, airplanes and satellites by suitable cameras.

Each of these cameras have different lens types and camera types. These images need to be fused using artificial intelligence into one precise 3D map of the forest area.

The 3D map will identify the species of plants in addition to measuring their density and physical characteristics like canopy height, trunk diameter etc. In this phase, , the soil will also be mapped for soil organic content using a combination of chemical testing and Computervision.

3rd phase



CORRELATING DATA TO IMAGES

The third phase involves correlating this data to images taken by drone, aircraft and satellite-mounted high-resolution hyper spectral cameras.

Depending on the accuracy required, the above three steps can be repeated at regular intervals. The last step if carried out alone will reveal carbon sequesterisation levels with a lower level of accuracy. The accuracy can be substantially improved if the second step is repeated as well. There is no need to repeat the first step.



Stage of technology

The technology components are all individually proven and commercially available. What is missing is the development of a method and protocol:

which is customised to the specific application of carbon sequestration measurement in a public forest and which is accurate, fast and cost effective with a analytics engine which can compare time series data to automatically determine trends.

The market needs a measurement protocol to gauge the improvement in carbon sequestration ability because of an intervention.

This intervention could be in the form of soil treatment, removal of invasive species, planting of new vegetation, provision of nutrients like fertilisers, water supply etc.



Competition

To the best of our knowledge there is no readily available solution for the output envisaged. There are several ways of guesstimating the carbon absorption capacity and these range from laboratory tests to bands that measure tree trunk growth. However those methods are expensive, time consuming and may not be as accurate in general.

There are some startups in Israel and other countries which are using machine learning to track growth of plantations etc. But there is no player who is has a method and protocol to monitor a diversified natural forest for carbon absorption.

The key advantage of an AI based system is that as more and more data is available and onboarded, the accuracy of estimation will keep improving.

The key point is that the study can be replicated and it will give the same results. This is not the case with lab samples which involve randomly chosen samples. The approach proposed is holistic, more accurate, more affordable and faster.



Business plan & commercialisation strategy

Our business plan is to offer carbon sequestration measurement as a service for a fee throughout the world. To the best of our knowledge, no such service is available.

This service would be valuable for issuer of carbon credits. Especially companies and other entities who are engaged in revitalising existing forests.



Societal impact of service

The entire climate change intervention framework is based on an efficient marketplace for carbon credits. This is the only way the polluters can be taxed on one side. And the entities doing reversal be paid for the same on the other side.

In a free market - the polluters will have to pay the cost of cleaning up through the carbon credit mechanism. There is a profit potential for any entity which can absorb carbon cost effectively.

Those companies which can reverse greenhouse gas emission and other culprits of climate change will get paid depending on the market dynamics. All of this is dependent on a reliable, proven and verifiable method and protocol for estimation



Consultants

Kodoy

Digital twin technology

Yogita Shukla

Remote Sensing

Ninand Mungi

Invasive species

Pradip Kishen

Social Forestry

Jagdish Krishnaswamy

Ecohydrologist

kodoy

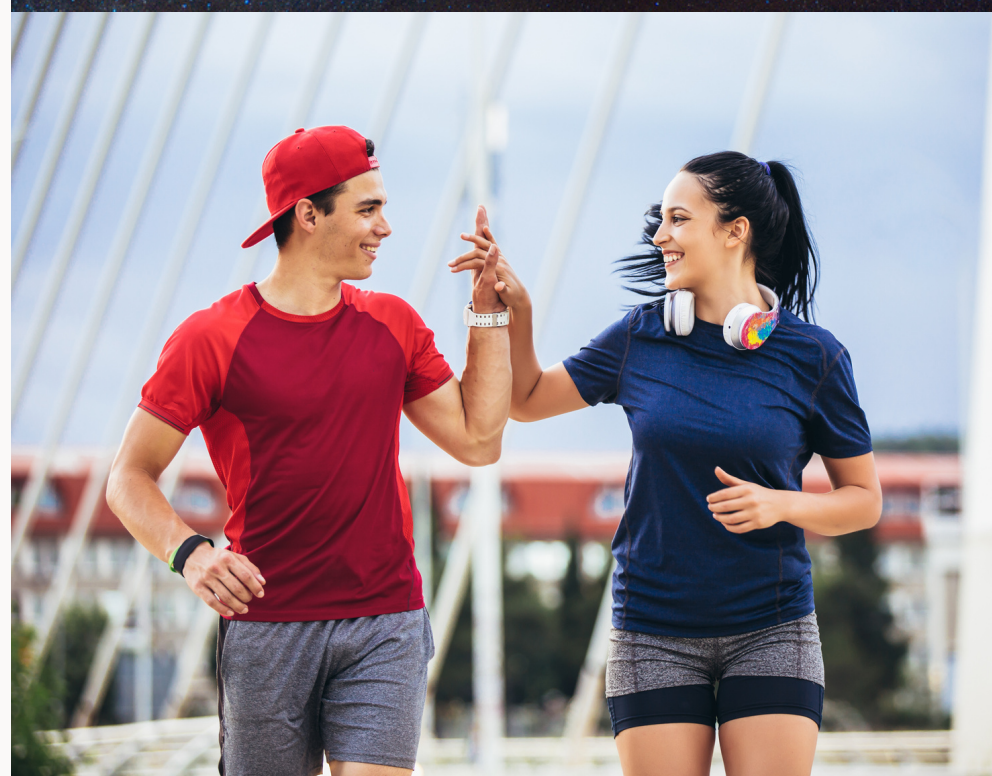
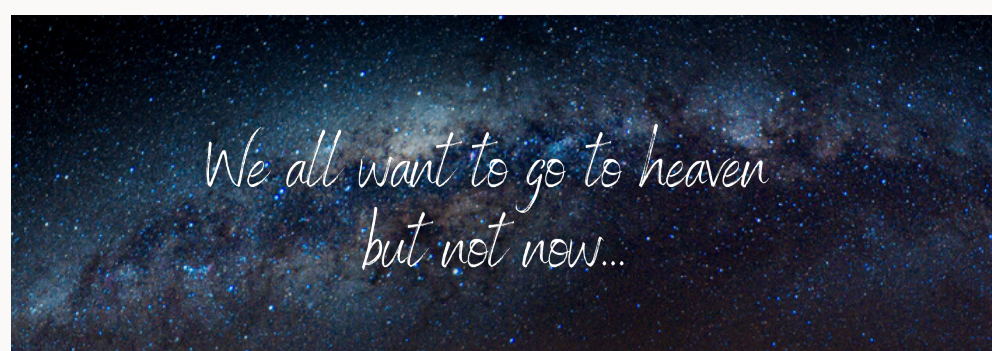
Digital twin technology

Kodoy is a data platform.

It applies DIGITAL TWIN technologies in the healthcare paradigm, from proactive and preventive to treatment approaches. Having a digital twin on standby is empowering in health optimisation and care, like never before.

At the heart of Kodoy's technology stack is the ability to fuse various sources of structured and unstructured data.

Kodoy compliments the various other entities of the MegaLab initiative of the IIT Alumni Council. These include the Ayushca Estates which are self contained smart villages which are like a completely self contained mini township with their own energy sources, organic farming and healthcare facilities.



DIGITAL TWIN
TECHNOLOGIES

...
an engineering approach
to enhancing healthspan

Yogita Shukla

Remote Sensing

Yogita is a zoologist with an MSc in Environmental science and a PhD in Space Sciences specialising in Remote Sensing from the Indian Institute of Remote Sensing (IIRS) Dehradun as a Research Centre of the University of Pune, India.

Yogita has a diverse experience of over 25 years in Environment and Geospatial Information Science focusing on Climate Change, Natural Resource Management, Energy Management, and Rural & Urban Development.

She is now working towards building sustainable systems with a holistic focus and linking diverse disciplines as a SciencePrenuer. Yogita is familiar with all aspects of remote sensing for the assessment of forest health.



Ninad Mungi

Invasive species

Dr Ninad Mungi is an ecologist with a passion for nature recovery and megafauna conservation. A botanist with a master's in geoinformatics and a PhD in forestry from the Forest Research Institute University at Dehradun in India. His Phd research involved using one of the largest biodiversity databases to assist ecological restoration in India.

As a post-doctoral fellow at Aarhus University in Denmark, his research focuses on nature-based solutions for global challenges with projects ranging from tiger recovery in India to climate change monitoring in the trans-Himalaya, and biodiversity recovery in invaded ecosystems.

For over a decade, he has been using cutting edge technology such as big data analytics, remote sensing, and biodiversity assessments to drive innovative solutions for global challenges. Ninad worked with the Wildlife Institute of India in 2021 to carry out an assignment on modelling biotic resistance of forests to biological invasions across the tropical systems.



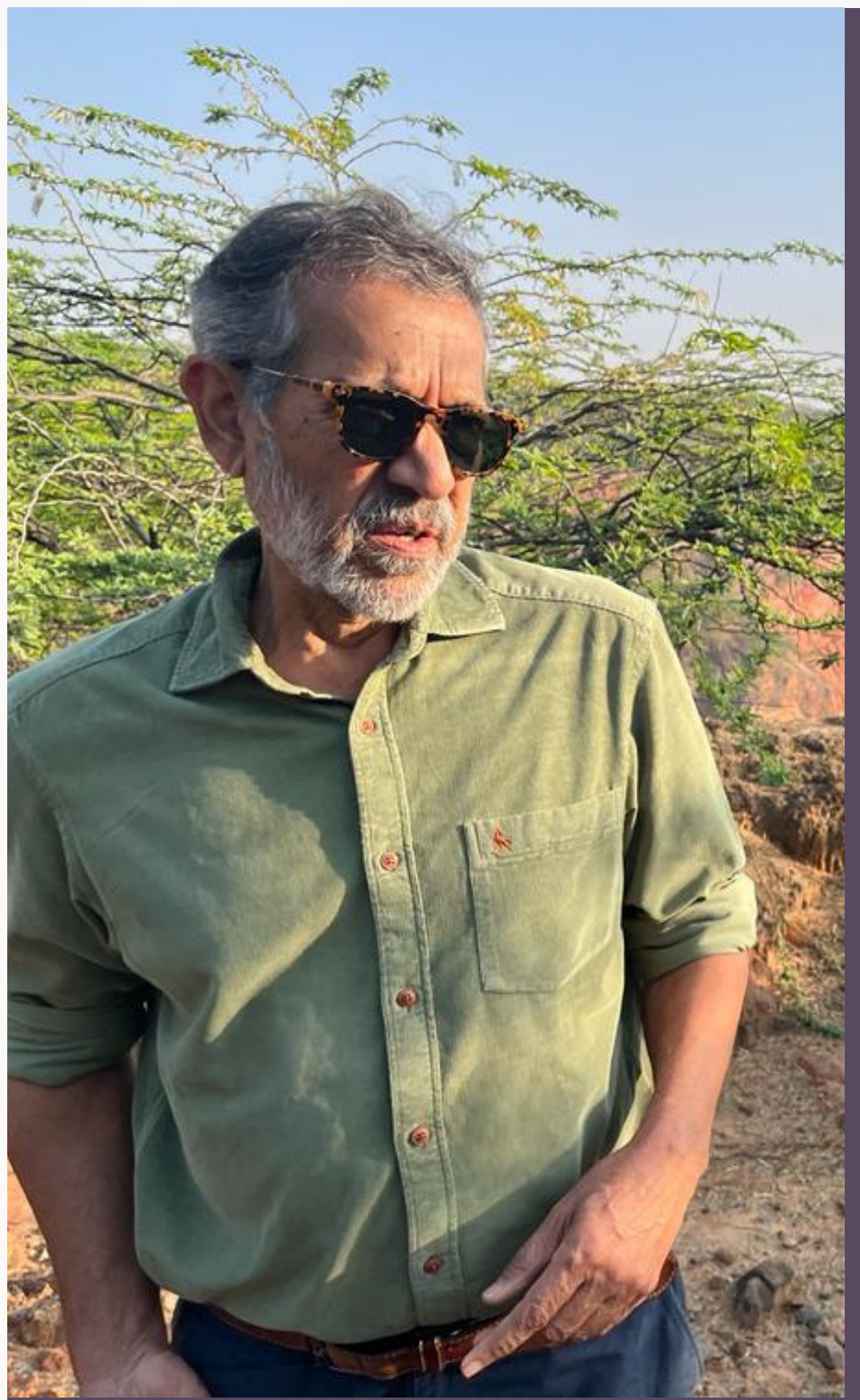
Pradip Kishen

Forestry

An award-winning documentary and feature film maker, Pradip Kishen is a graduate of St Stephens, Delhi University and Balliol College, Oxford University.

For the last twenty years, he has been doing pioneering restoration work in North India and has been involved with creating some iconic bio-diverse vegetation hubs in desert areas. These include desert parks in Jodhpur and Jaipur of around 70 hectares each.

Pradip started writing about trees and forests in 1987. He has authored several books on Indian trees and forests and is widely regarded as the most authoritative source on the subject globally. His books on trees of Delhi and North India are by far the most respected and referred-to publications in the forest revitalisation domain.



Jagdish Krishnaswamy

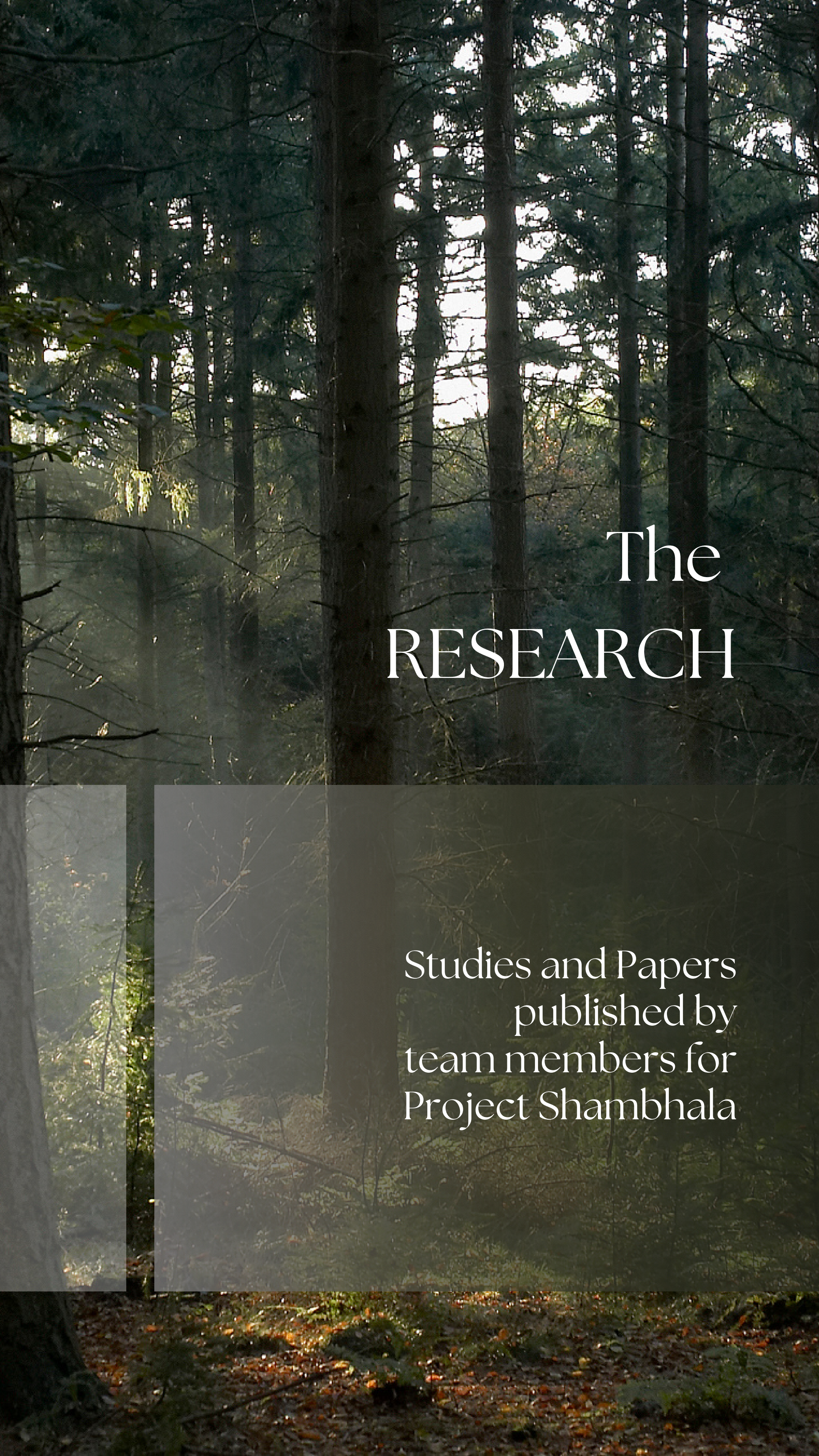
Environment

An ecohydrologist, academician and subject matter expert in environmental studies, Dr Krishnaswamy is a civil engineer who graduated from IIT Bombay and holds a Master's and PhD from Duke University in Environmental sciences. His post-doctoral work in Ecology and Environment was at the Ashoka Trust for Research, where he served as a fellow and Professor till 2021. He is the Dean of the School of Environment & Sustainability at the Indian Institute of Human Settlements in Bangalore, India

He was awarded the Distinguished Fellow in ecohydrology for 2023 by the IIT Alumni Council.

Dr Krishnaswamy has coordinated the establishment of instrumented catchments in the Western Ghats and in the Himalayas to study the impact of land cover and climate variability on hydrological processes.





The RESEARCH

Studies and Papers
published by
team members for
Project Shambhala

Prioritising India’s landscapes for biodiversity, ecosystem services and human well-being

• • • • • • • • Arjun Srivathsa et al., Nat Sustain 6, 568–577 (2023).
• • • • • • • • <https://doi.org/10.1038/s41893-023-01063-2>
• • • • • • • •

Ecosystem-level carbon storage and its links to diversity, structural and environmental drivers in tropical forests of Western Ghats, India

• • • • • • • • Kothandaraman, S., Dar, J.A., Sundarapandian, S. et al. Sci Rep
• • • • • • • • 10, 13444 (2020). <https://doi.org/10.1038/s41598-020-70313-6>
• • • • • • • •

Greater stability of carbon capture in species-rich natural forests compared to species-poor plantations

• • • • • • • • Anand M Osuri et al 2020 Environ. Res. Lett. 15 034011DOI
• • • • • • • • [10.1088/1748-9326/ab5f75](https://doi.org/10.1088/1748-9326/ab5f75)
• • • • • • • •

Tree diversity and carbon storage co-benefits in tropical human-dominated landscapes

• • • • • • • • Anand M. Osuri et al., January 2020
• • • • • • • •
• • • • • • • •
• • • • • • • •

Dry-forest tree species with large seeds and low stem specific density show greater survival under drought

• • • • • • • • Published online by Cambridge University Press: 26 January
• • • • • • • • 2019 | Lalitha Krishnan, Deepak Barua and Mahesh Sankaran
• • • • • • • •

Altered stand structure and tree allometry reduce carbon storage in evergreen forest fragments in India’s Western Ghats

• • • • • • • • National Centre for Biological Sciences,
• • • • • • • • Tata Institute of Fundamental Research,
• • • • • • • • Nature Conservation Foundation,
• • • • • • • • School of Biology, University of Leeds
<https://doi.org/10.1016/j.foreco.2014.01.039>

annexure I

The RESUMÉS

Of the Project Team
and Consultants

Communications



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Plans to protect
air and water, wilderness
and wildlife are, in fact,
plans to protect man.

Stewart Udall

